Neurophysiological alterations during phoneme and word processing in the acute stage of aphasia

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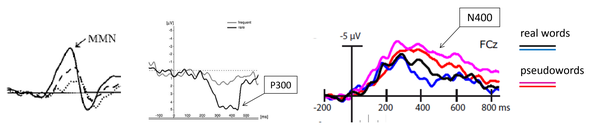
BACKGROUND

Possible to investigate phonological input processes using event-related potentials (ERPs)

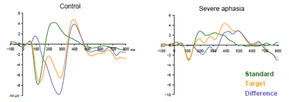
Mismatch Negativity (MMN) and P300 reflect phoneme discrimination
→ pre-attentive and attentive deviance detection in oddball task (interspersing frequent stimuli with rare, infrequent stimuli)

Possible to investigate single-word processing using ERPs

N400 for word recognition/comprehension
→N400 to pseudowords (PW) larger than N400 to real words (RW) = 'pseudoword effect'



Studies implementing these ERPs in aphasic patients work with chronic patients and use non-speech stimuli or do not compare different speech stimuli (distinctive features):



BUT MMN, P300 and N400 are sensitive to reveal the neurophysiological substrate of the language problem (amplidue ↓, latency ↑, topographical reorganisation)

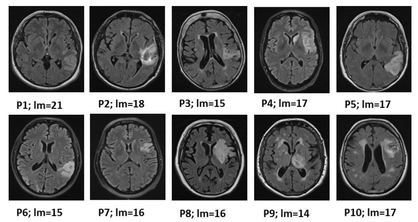
Only a few studies have used ERPs in acute aphasic patients [1,2] !!!

→ **NONETHELESS** ERPs = valuable complement in the clinical evaluation of acute aphasic patients → when behavioural assessment is difficult or impossible!
→ **Before clinical use,** the following research questions first need to be answered:

1) Difference between **place, manner and voicing** during pre-attentive and attentive auditory phoneme discrimination?
2) What is the effect when **more attention** is required? Is the attentive task **appropriate for clinical use**?
3) Can acute aphasic patients **discriminate between real words and pseudowords**?

MATERIALS AND METHOD

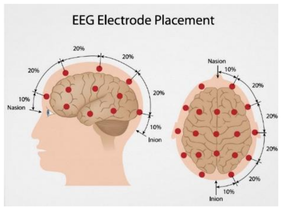
Patient group
10 patients: 5 men/5 women
Mean age: 69.4 jaar (+/- 3.46)
< 2 weeks post-stroke = acute stage!



Norm group [3]
44 subjects: 20 men/24 women
Equivalent mean age *(p = 0.785)*

Behavioural testing
AAT (only patients)
PALPA (subtests phonological input)

Neurophysiological testing
Electroencephalogram (EEG) recorded through 23 electrodes
→ international 10-20 system



Phoneme discrimination based on 3 distinctive features (place, manner, voicing)
→ 6 oddball paradigms (3 distinctive features, pre-attentive and attentive condition)

Word recognition based on RW – PW contrast
→ 1 oddball paradigm (passive)

Analysis (BrainVision Analyzer)
Filter 0.5-30 Hz → ICA → segmentation → artefact rejection → averaging stimuli **= ERP**

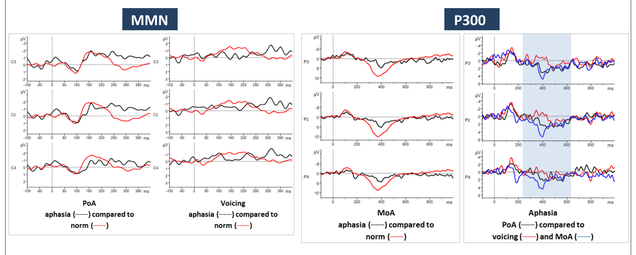
RESULTS

Phoneme discrimination

	Place	Manner	Voicing
MMN	aphasia = norm	aphasia = norm	aphasia < norm
P300	aphasia < norm	aphasia < norm	aphasia < norm

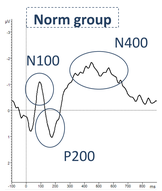
MMN: more right-lateralized instead of left-lateralized **= compensation mechanism [4]?**

Within the aphasic patients
→**MMN:** place > voicing; place > manner; voicing = manner
→**P300:** place > voicing; place = manner; voicing = manner

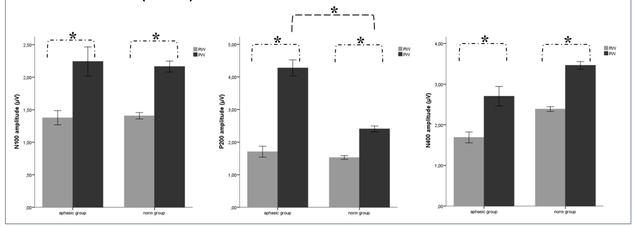


Word recognition

Aphasic patients
→ intact pseudoword effect = pseudowords > real words (N100, P200, N400)
→ **P200:** PW aphasic patients > PW norm group



BUT timing differences!!
→ Aphasic patients are slower than the norm group during processing of pseudowords (N100, P200 and N400) and real words (P200)!



DISCUSSION AND CONCLUSION

Phoneme discrimination

Place of articulation less subject to neuronal loss?
→ More spared than manner and voicing
→ Better imprinted because of larger spectral differences and/or additional auditory-motor interface [5]?

Effect attention!!
→ Pre-attentive = only voicing diminished compared to norm
→ Attentive = all 3 distinctive features diminished compared to norm
→ Neuronal resources for attention allocation supress neuronal activation dedicated to deviance detection?

Word recognition

Intact pseudoword effect in aphasic patients
→Detection of irregular phonological structure and difference in lexical status
→**BUT** more cognitive effort/less inhibition during processing of lexical properties (P200 ↑)[6]
→Less efficient information transfer (delay compared to the norm group) does not have a negative effect on lexical processing ↔ disturbed semantic integration [7]

Concluding remarks

The paradigms seem to be sensitive enough for clinical, neurophysiological evaluation of phoneme discrimination and word recognition in acute aphasia

HOWEVER

Be critical when using the attentive task (P300 potential) because of other influencing cognitive factors!

References

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